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Extended essay cover

Diploma Programme subject in which this extended essay is registered: WORLD STUDIES: ECONOMICS / GEOGRAPHY

(For an extended essay in the area of languages, state the language and whether it is group 1 or group 2.)

Title of the extended essay: The Effects of the Great East Japan
Earthquake on The World's Economy

Candidate's declaration

This declaration must be signed by the candidate; otherwise a grade may not be issued.

The extended essay I am submitting is my own work (apart from guidance allowed by the International Baccalaureate).

I have acknowledged each use of the words, graphics or ideas of another person, whether written, oral or visual.

I am aware that the word limit for all extended essays is 4000 words and that examiners are not required to read beyond this limit.

This is the final version of my extended essay.

Supervisor's report and declaration

The supervisor must complete this report, sign the declaration and then give the final version of the extended essay, with this cover attached, to the Diploma Programme coordinator.

Name of supervisor (CAPITAL letters)

Please comment, as appropriate, on the candidate's performance, the context in which the candidate undertook the research for the extended essay, any difficulties encountered and how these were overcome (see page 13 of the extended essay guide). The concluding interview (viva voce) may provide useful information. These comments can help the examiner award a level for criterion K (holistic judgment). Do not comment on any adverse personal circumstances that may have affected the candidate. If the amount of time spent with the candidate was zero, you must explain this, in particular how it was then possible to authenticate the essay as the candidate's own work. You may attach an additional sheet if there is insufficient space here.

Initially struggled. Finding resources for such a recent event proved to be a challenging goal for her, but in the end she persevered and she was able to put together a document that she is proud of.

Managing and organizing the information she found also proved to be daunting. On the whole she was able to synthesize information in a clear manner.

This declaration must be signed by the supervisor; otherwise a grade may not be issued.

I have read the final version of the extended essay that will be submitted to the examiner.

To the best of my knowledge, the extended essay is the authentic work of the candidate.

I spent hours with the candidate discussing the progress of the extended essay.

Assessment form (for examiner use only)

| Criteria | Achievement level | | | | | |
|-------------------------------|-------------------|---------|------------|---------|------------|--|
| | Examiner 1 | maximum | Examiner 2 | maximum | Examiner 3 | |
| A research question | 1 | 2 | | 2 | | |
| B introduction | 1 | 2 | | 2 | | |
| C investigation | 3 | 4 | | 4 | | |
| D knowledge and understanding | 2 | 4 | | 4 | | |
| E reasoned argument | 3 | 4 | | 4 | | |
| F analysis and evaluation | 1 | 4 | | 4 | | |
| G use of subject language | 2 | 4 | | 4 | | |
| H conclusion | 1 | 2 | | 2 | | |
| I formal presentation | 3 | 4 | | 4 | | |
| J abstract | 1 | 2 | | 2 | | |
| K holistic judgment | 2 | 4 | | 4 | | |
| Total out of 36 | 20 | | | | | |

The effects of the Great East Japan Earthquake on the world's economy

Candidate Name:

Candidate Number:

Session: May 2014

Extended Essay Advisor:

School:

Word Count: 3,955

ABSTRACT

My choice for the extended essay topic "The effects of the Great East Japan Earthquake on the world's economy" was motivated by the way this tragic event affected our understanding and awareness of the destructive forces of nature and the risks associated with nuclear energy technology.

As one of the largest natural disaster known to humanity in the modern history, the 9.0 Great East Japan Earthquake, the tsunami and the major nuclear incident which followed, generated tremendous destruction. Many thousands of lives were lost and millions of people in Japan experienced tragedies for which we can only offer our compassion and humanitarian help.

I decided to focus on the economical aspects because it was a subject initially less obvious and not so extensively debated but I considered it may be affecting many of us in a more tangible manner in the foreseeable future. After 2 years we have data publically available regarding the immediate, short and partially medium term economical consequences while the long term effects are yet to be projected. The physical destruction was important, reaching hundreds of billions and temporarily impacting many businesses around the world but the people attitude towards nuclear energy is changing, influencing the fossil fuels and renewable energy markets and the future of energy production policies.

In order to complete this study I compiled information retrieved from research on the available data that has been published by official sources, scientific community, and the public and private international organizations. While briefly presenting the main characteristics of this tragic event and the influential role of media on markets and public opinion, the focus of this essay is on its impact on the Japanese and global economy in their immediate, short, medium and long term projected effects as realized today.

Word Count: 293

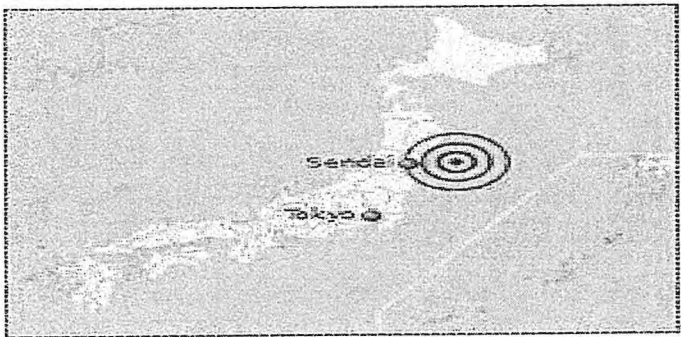
TABLE OF CONTENTS

| | |
|---|----|
| 1.Description of Triple Nature of the Great East Japan Earthquake Event_ | 4 |
| 2.Immediate Destruction, Global Reactions and Media Coverage_____ | 7 |
| 3.Evaluation of Immediate Economical Effects Globally and Locally in Japan _____ | 12 |
| 4.Short and Medium Term Effects on Japan's and the Global Economy _ | 14 |
| 5.Long Term Economical Effects Projections Locally And Globally _____ | 17 |
| 6.Conclusions _____ | 19 |

1. Description of Triple Nature of the Great East Japan Earthquake Event

Earthquake

The magnitude 9.0 Great East Japan Earthquake occurred on Friday March 11, 2011 at 05:46:24 UTC (02:46:24 PM local time) near the east cost of Honshu island of Japan with the hypocenter at a depth of 30km. It was caused by a sudden rupture in the Japan trench subduction zone where the Pacific oceanic plate is subducting the Eurasian continental plat. A part of the subduction zone measuring 300km in length and 95km width lurched as much as 50m in east-west direction and thrust upwards about 10m. It was preceded by several foreshocks including a 7.2 magnitude event and almost 2 thousands aftershocks including 3 events of magnitude between 7.0 and 7.9¹



On a global scale, the earthquake shifted the Earth's axis by estimates of between 10-25cm. This deviation led to a number of small planetary changes, including the length of a day and the tilt of the Earth. Earth's rotation speed increased, shortening the day by 1.8 microseconds due to the redistribution of Earth's mass.³ The earthquake was felt as far as Eastern Russia, Taiwan and China

Tsunami

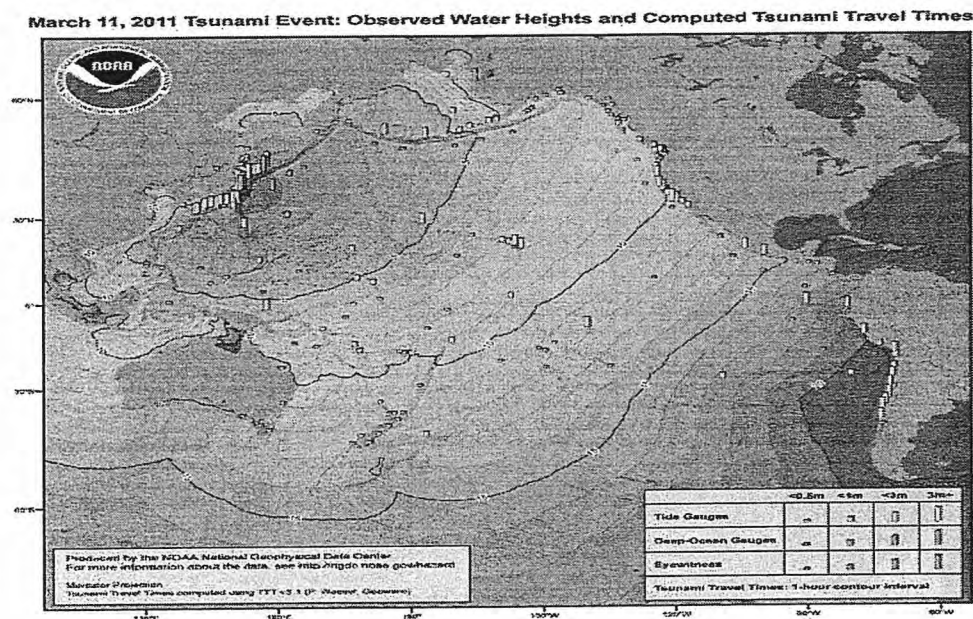
Due to the upward thrust of the tectonic plate, estimated up to 10m over an area of 160sqkm of ocean floor, created a major tsunami. Besides the Japan and Eastern Asia shores,

¹ Kenneth Pletcher, Enciclopedia Britannica, 2011, <http://www.britannica.com/EBchecked/topic/1761942/Japan-earthquake-and-tsunami-of-2011>

² USGS, March, 11th, 2011, <http://earthquake.usgs.gov/earthquakes/eqinthenews/2011/usc0001xgp/>

³ Richard Gross, NASA's Jet Propulsion Lab, <http://www.npr.org/2011/03/18/134658880/Japan-Earthquake-May-Have-Changed-Earths-Axis>

the tsunami went eastward throughout the Pacific Ocean to North and South America and southwards to Philippines, Indonesia, Northern Australia and New Zealand.



4

Early tsunami warnings were issued at 14:49 just 3 minutes after the earthquakes with initial height estimated at 3m and later raised to 10m. The offshore the height of the measured wave along Japan's coast reached a maximum of 7.3m but due to the shoaling effect it reached heights above 10m in many areas and up to 24-30m in the port of Ōfunato area and 39-40.5m in Miyako region.⁵

Tsunami warnings were issued for Russia's Kuril Islands, Hawaii, Canada and US West Coast and most of South American Pacific shores. Wave heights up to 1m were recorded on Vancouver Island, up to 2.8m in California and Oregon, 1.5m in Peru, 3m in Chile.

Fukushima Daiichi nuclear incident

During the initial earthquake many nuclear reactors in Japan were automatically shut down by the built in protection systems but in the case of Fukushima Daiichi plant, the following tsunami which measured 13-15m at the location flooded the premises and destroyed the backup diesel generators needed to circulate the coolant and keep the reactors cool. Without power, the critical systems required to keep the reactors in a safe shutdown state stopped operating and the cores overheated causing partial meltdowns. Explosions due to hydrogen gas release occurred in reactors 1, 2 and 3 and a fire affected reactor 4 building which led to

⁴ Picture source: Coasts, Oceans, Ports & Rivers Institute, 2011

<http://www.asce.org/copri/COPRIContent.aspx?id=12884906100&LangType=1033&css=print>

⁵ Wikipedia, http://en.wikipedia.org/wiki/2011_T%C5%8Dhoku_earthquake_and_tsunami

significant levels of atmospheric radiation release. At the time of the accident, the reactor units and central storage facility contained the following numbers of fuel rod assemblies totaling 1600⁶ tons of nuclear fuel:

| Location | Unit 1 | Unit 2 | Unit 3 | Unit 4 | Unit 5 | Unit 6 | Central Storage |
|-------------------------------------|-----------------|-----------------|----------------------|-----------------|-----------------|-----------------|----------------------|
| Reactor Fuel Assemblies | 400 | 548 | 548 | 0 | 548 | 764 | 0 |
| Spent Fuel Assemblies | 292 | 587 | 514 | 1331 | 946 | 876 | 6375 ^[32] |
| Fuel | UO ₂ | UO ₂ | UO ₂ /MOX | UO ₂ | UO ₂ | UO ₂ | UO ₂ /MOX |
| New Fuel Assemblies ^[31] | 100 | 28 | 52 | 204 | 48 | 64 | N/A |

Radiation levels exceeding safety limits have been recorded in many instances across Japan including Tokyo and as of July 2011 the Japanese government has been reportedly unable to control the spread of radioactive material into the nation's food. Radioactive material has been detected in a range of products, including spinach, tea leaves, milk, fish and beef, up to 200 miles from the nuclear plant. In a 2012 interview, the former prime minister Naoto Kan said that at one point that Japan faced a situation where there was a chance that people might not be able to live in the capital zone including Tokyo and would have to evacuate:

"If things had reached that level, not only would the public have had to face hardships but Japan's very existence would have been in peril".⁸

Higher than normal radiation levels have been detected within a few days across North America and Europe due to the normal atmospheric air masses circulation but there were no alerts or reports of radiation levels exceeding the legal limits. US EPA agency continuously released radiation recordings to public and Health Canada Radiation Monitoring Data showed that while there were significant increases of fission resultant isotopes as I-131 and Cs-137 there was no increase in the daily dose of radiation. Import food inspections have been instated in many countries for products originating in affected Japanese prefectures and for fishing products.⁹

⁶ Wikipedia citing Japan Times article by Martin Alex, March 20th, 2011,

http://en.wikipedia.org/wiki/Fukushima_Daiichi_nuclear_disaster

⁷ Wikipedia citing Japan Times article by Martin Alex, March 20th, 2011,

http://en.wikipedia.org/wiki/Fukushima_Daiichi_nuclear_disaster

⁸ Reuters citing Premier Naoto Kan, Feb 17, 2012, <http://www.reuters.com/article/2012/02/17/us-japan-kan-idUSTRE81G08P20120217>

⁹ Health Canada Radiation monitoring data http://www.hc-sc.gc.ca/hc-ps/ed-ud/respond/nuclea/data-donnees-eng.php#ddrl_mar2011

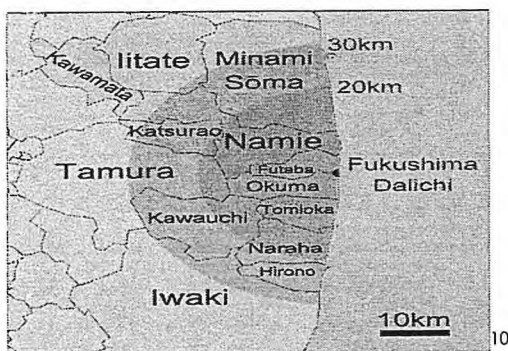
2. Immediate Destruction, Global Reactions and Media Coverage

Immediate destruction

The Earthquake was mainly felt in Japan causing direct destructions including structural damages, severed bridges and roads, building collapses, fires and a small number of casualties, these were all dwarfed by the effects of the destructive tsunami which followed.

The tsunami had devastating effects on many cities and communities on Japan's East coast with 15883 deaths, 2676 people missing and 6144 injured confirmed so far. The number of casualties would have been significantly higher without the high grade of preparedness of the Japanese population and the early warning systems which helped limiting the life loss. The extent of damage was enormous with 45,700 buildings destroyed and 144,300 damaged including 300 hospitals of which 11 were completely destroyed; 230.000 automobiles were damaged or destroyed, 4.4 million households lost power and 1.5 million lost water supply.

Across Pacific, evacuations have been ordered in Russia and tsunami warnings issued for Canada and US Pacific Coast. Damages reached \$17mil and one loss of life was recorded in Oregon. Hawaii had estimated damages to several tens of millions, 300 homes destroyed in Peru, 200 in Chile and smaller level destructions in Indonesia, New Zealand, Papua New Guinea and Mexico. Huge quantities of debris were pulled by the retreating floodwaters in the Pacific Ocean and the floating debris traveled towards the North American shores where they reached starting the spring of 2012. Immediately after the nuclear incident was reported, due to possible radiation exposure an initial 20km exclusion area around the plant was established (later extended to 30km) and more than 140.000 residents were evacuated.



The gravity and extent of the Fukushima Daiichi incident is still heavily debated, with the amounts of radiation released estimated between 10-20% to 300% compared to the largest nuclear accident ever recorded - Chernobyl 1986. Besides the atmospheric contamination, the high amount of radioactive materials released in the seawater make the estimates extremely

¹⁰ Wikipedia, http://en.wikipedia.org/wiki/Fukushima_Daiichi_nuclear_disaster

difficult. Poor communication from the Japanese government and the responsible company - TEPCO (Tokyo Electric Power Company) increased the uncertainty and fueled many catastrophic scenarios which spread around the world and sparked a widespread movement against nuclear power. While scientific data for Chernobyl incident is available and considering the exploded reactor had been sealed within 6 months after the occurrence, preventing further radioactive releases with a very high effort and cost of humans lives, the Fukushima reactors are still leaking with a predicted full cleanup period of 40 years as announced by the Japanese government on Dec 21st 2011.¹¹

Media coverage

All international media covered the event extensively causing market reactions and sparking people concerns regarding nuclear energy, constituting an important factor of economical influence. There are no less than 44 million web pages associated to Fukushima as a simple Google search suggests while only 4.5 million hits for Chernobyl which is still considered to be the largest nuclear disaster in history. For The New York Times alone, a search of its website for the term Fukushima from March 11 to June 26, 2011 found 440 articles. According to the Tyndall Report, in the first few days there were 29 nightly newscasts from ABC, CBS, and NBC that included coverage of the nuclear accident.¹²

A study published in August 2012 by Ivan Katchanovski, Ph.D., Department of Communication & School of Political Studies, University of Ottawa makes a comparison of the media coverage in Canada and US analyzing the influence of the political factor showing that 66% of the networks presented the Fukushima incident as less severe than Chernobyl despite both being rated by IAEA as a level 7 incident:

*"Only 7 percent of references in American news reports and 2 percent in Canadian reports characterized the Fukushima nuclear accident in all its aspects as being more severe than Chernobyl"*¹¹

He also published a detailed comparison between the way the two similar events were treated by public and private media in US and Canada:

¹¹ CBS News April 22, 2013 http://www.cbsnews.com/8301-202_162-57580704/fukushima-nuclear-plant-shutdown-may-take-japan-longer-than-predicted-40-years-warns-u-n-agency/

¹² Tyndall Report, <http://tyndallreport.com/yearinreview2011/>

Table 3. Severity of all aspects of the Fukushima nuclear disaster, compared to the Chernobyl nuclear disaster, by a TV network, percent

| | U.S. networks | | | | Canadian networks | |
|--------------------|---------------|-----|-----|-----|-------------------|-----|
| | ABC | CBS | FOX | NBC | CTV | CBC |
| Less severe | 49 | 61 | 78 | 86 | 73 | 60 |
| Similar/comparable | 38 | 34 | 14 | 9 | 27 | 37 |
| More severe | 13 | 5 | 8 | 6 | 0 | 3 |
| Total, percent | 100 | 100 | 100 | 100 | 100 | 100 |
| N | 45 | 85 | 37 | 35 | 22 | 30 |

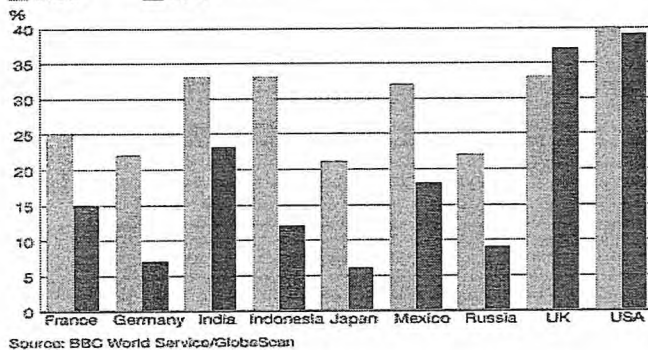
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The media coverage resulted in a sharp decline in nuclear power acceptance mainly in Europe as shown by this BBC study covering 12 countries:

Shifting opinions

Agree: Nuclear power is relatively safe/important electricity source/should build new plants

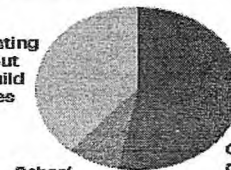
2005 2011



Source: BBC World Service/GlobeScan

Views on use of nuclear energy for electricity generation*

Use existing plants but don't build new ones 39%



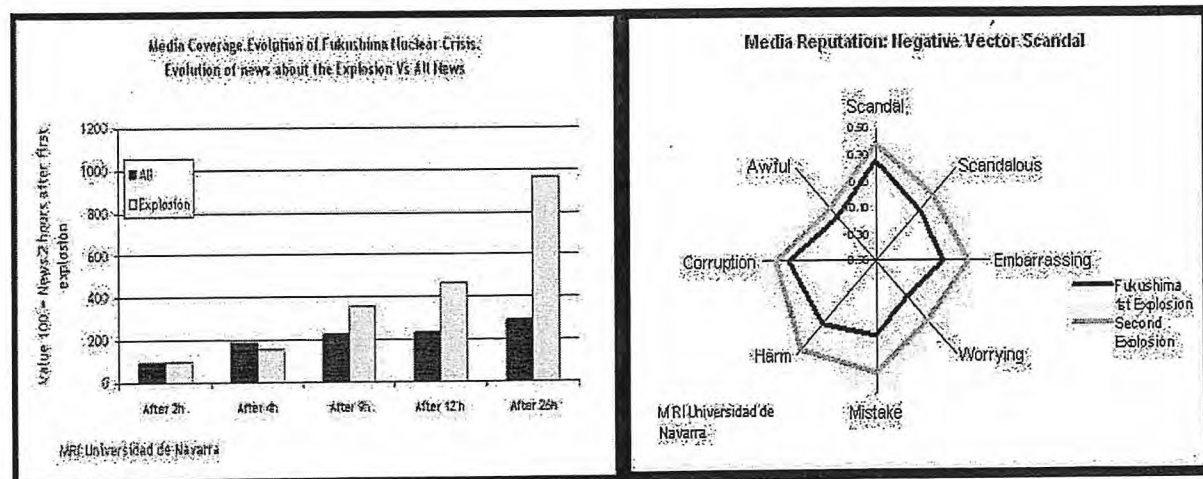
Build new nuclear power plants 22%

Close all operating nuclear power plants 30%

Sources: BBC Global Poll conducted by GLOBEscan.com
*Average of 12 countries (Brazil, China, France, Germany, India, Japan, Mexico, Pakistan, Russia, Spain, UK and USA), 2011

14

Another study published in March 2012 by Reputation Metrics shows how the media focus moved sharply within hours from the earthquake and tsunami disaster to the nuclear aspect following the series of explosions:



15

¹³ Ivan Katchanovski, Ph.D, University of Ottawa, ON 2012

[http://www.academia.edu/1890136/Fukushima vs. Chernobyl Coverage of the Nuclear Disasters by American and Canadian Media](http://www.academia.edu/1890136/Fukushima_vs._Chernobyl_Coverage_of_the_Nuclear_Disasters_by_American_and_Canadian_Media)

¹⁴ Richard Black, BBC News, Nov 24, 2011 <http://www.bbc.co.uk/news/science-environment-15864806>

¹⁵ Pictures from: Reputation Metrics, March 2011, <http://reputation-metrics.org/tag/media-coverage/>

Many companies around the world were affected immediately in terms of media coverage. The tables below show the media coverage impact calculated by comparison to the average of the top 600 companies provided by STOXX Index with distinction between the effects of the tsunami destruction and the nuclear incident. From the table below we can see for example that General Electric Co. (market value \$250bln) has been mentioned 37.1 times more than the average in connection to the nuclear accident causing temporary stock value fluctuations. In fact, General Electric lost temporarily 28% of shares value in the 6 months following the accident while it was on a growing trend since 2008.

Most affected companies in Europe by Japan earthquake, tsunami and nuclear crisis, by media impact.

| Rank | Company | Media Impact | Tsunami | Nuclear |
|------|------------------|--------------|---------|---------|
| 1 | ROYAL DUTCH | 43.2 | | |
| 2 | EDF | 34.3 | | |
| 3 | LUFTHANSA | 34.1 | | |
| 4 | RWE | 33.1 | | |
| 5 | BARCLAYS | 26.5 | | |
| 6 | CREDIT SUISSE | 23.8 | | |
| 7 | AIR FRANCE | 21.1 | | |
| 8 | SWISS RE | 20.0 | | |
| 9 | BNP | 14.6 | | |
| 10 | ALLIANZ | 13.2 | | |
| 11 | COMMERZBANK | 12.4 | | |
| 12 | DAIMLER | 11.8 | | |
| 13 | TELEFONICA | 10.2 | | |
| 14 | UBS | 9.6 | | |
| 15 | VOLKSWAGEN | 8.1 | | |
| 16 | HANNOVER RE | 8.0 | | |
| 17 | BMW | 7.9 | | |
| 18 | LLOYDS | 7.3 | | |
| 19 | BP | 7.1 | | |
| 20 | SOCIETE GENERALE | 6.9 | | |
| 21 | RENAULT | 6.9 | | |
| 22 | E.ON | 6.4 | | |
| 23 | BRITISH AIRWAYS | 6.3 | | |
| 24 | SIEMENS | 5.5 | | |
| 25 | DEUTSCHE BANK | 5.3 | | |
| 26 | LVMH | 4.9 | | |
| 27 | AXA | 4.2 | | |
| 28 | SAP | 4.1 | | |
| 29 | PORSCHE | 4.1 | | |
| 30 | LEGRAND | 3.9 | | |
| 31 | BAYER | 3.9 | | |
| 32 | RIO TINTO | 3.8 | | |
| 33 | UNICREDITO | 3.8 | | |
| 34 | GAS NATURAL | 3.5 | | |
| 35 | VOLVO | 3.5 | | |
| 36 | HSH | 3.4 | | |
| 37 | ERICSSON | 3.4 | | |
| 38 | ANTOFAGASTA | 3.4 | | |
| 39 | LANXESS | 3.2 | | |
| 40 | BASF | 3.2 | | |
| 41 | HEIDELBERGCEMENT | 3.1 | | |
| 42 | PPR | 3.1 | | |
| 43 | BHP BILLITON | 3.0 | | |
| 44 | NOKIA | 3.0 | | |
| 45 | PEARSON | 3.0 | | |
| 46 | AVIVA | 2.9 | | |
| 47 | KINGFISHER | 2.8 | | |
| 48 | SCHROEDERS | 2.7 | | |
| 49 | ENI | 2.7 | | |

Media, Reputation and Intangibles center, MRI Universidad de Navarra

Most affected companies in America by Japan earthquake, tsunami and nuclear crisis, by media impact (as for March 21, 2011)

| Rank | Company | Media Impact | Tsunami | Nuclear |
|------|-----------------------------|--------------|---------|---------|
| 1 | General Electric | 37.1 | | |
| 2 | Moody's | 32.9 | | |
| 3 | JPMorgan | 27.5 | | |
| 4 | AFLAC | 24.2 | | |
| 5 | Goldman Sachs | 18.5 | | |
| 6 | General Motors | 15.1 | | |
| 7 | Caterpillar | 10.6 | | |
| 8 | Bank of America | 10.1 | | |
| 9 | Bosch | 9.8 | | |
| 10 | Southern Co. | 9.4 | | |
| 11 | Wal-Mart | 9.2 | | |
| 12 | Exxon | 8.5 | | |
| 13 | Intel | 8.0 | | |
| 14 | Verizon | 6.7 | | |
| 15 | Microsoft | 6.7 | | |
| 16 | Chigroup | 6.3 | | |
| 17 | FedEx | 6.1 | | |
| 18 | Morgan Stanley | 5.8 | | |
| 19 | Apple Inc. | 5.5 | | |
| 20 | Lehman Brothers | 5.2 | | |
| 21 | Intel Corp. | 5.1 | | |
| 22 | Exxon | 5.1 | | |
| 23 | Starbucks | 5.0 | | |
| 24 | Wells Fargo | 4.9 | | |
| 25 | Tiffany | 4.8 | | |
| 26 | Chevron | 4.3 | | |
| 27 | Amazon | 4.2 | | |
| 28 | IBM | 4.0 | | |
| 29 | Exxon | 4.0 | | |
| 30 | Merrill Lynch | 4.0 | | |
| 31 | Nike | 3.6 | | |
| 32 | Texaco Instruments | 3.4 | | |
| 33 | Comcast | 3.4 | | |
| 34 | eBay | 3.2 | | |
| 35 | Walt Disney | 3.1 | | |
| 36 | Cisco | 3.1 | | |
| 37 | Prudential | 3.0 | | |
| 38 | Hartford Financial Services | 2.9 | | |
| 39 | AMK | 2.8 | | |
| 40 | Abbott | 2.8 | | |
| 41 | Campbell | 2.8 | | |
| 42 | Hewlett-Packard | 2.7 | | |
| 43 | ATI | 2.6 | | |
| 44 | Harley-Davidson | 2.5 | | |
| 45 | McDonald's | 2.5 | | |
| 46 | 3M | 2.5 | | |
| 47 | Coca-Cola | 2.4 | | |
| 48 | Google Inc. | 2.7 | | |
| 49 | National Semiconductor | 2.7 | | |

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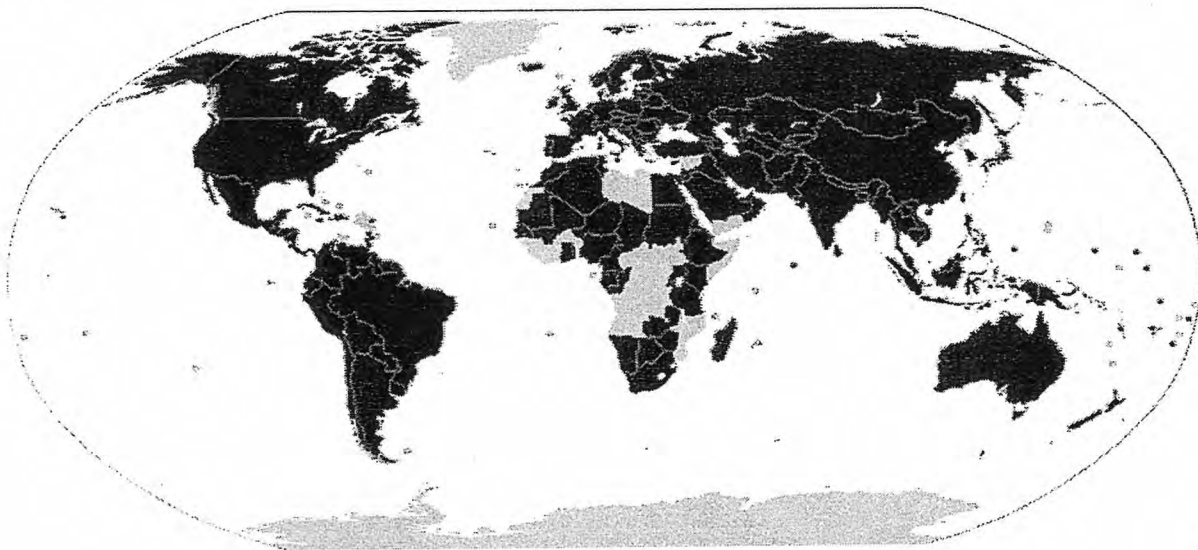
16

¹⁶ Reputation Metrics, March 2011, <http://reputation-metrics.org/2011/03/27/american-companies-most-affected-by-japan-earthquake-tsunami-or-fukushima-nuclear-crisis-by-media-impact/>

Global reactions

Around the world the international community had a prompt reaction to the suffering of the Japanese people. Many governments and international organizations offered their help and significant donations have been made by governments, non-governmental organizations, corporations and private persons. Wikipedia lists the most important contributions and mentions that as of March 2012, within one year from the disaster donations totaled 520bln Yen (\$5.3bln) and 930,000 volunteers assisted the people affected.¹⁷ 128 countries and 33 international organizations offered their immediate assistance as reported by the Japan's foreign ministry on March 19th 2011.

Map of countries that offered humanitarian support:



18

¹⁷ Wikipedia, Humanitarian response to the 2011 Tōhoku earthquake and tsunami,
http://en.wikipedia.org/wiki/Humanitarian_response_to_the_2011_T%C5%8Dhoku_earthquake_and_tsunami

¹⁸ Wikipedia,
http://en.wikipedia.org/wiki/File:Map_of_humanitarian_support_to_the_Great_Eastern_Japan_Earthquake.svg

3. Evaluation of Immediate Economical Effects Globally and Locally in Japan

Shortly after the event the extent of destruction was evaluated with the exception of the Fukushima Daiichi nuclear incident that could not be contained or estimated for a long period of time.

Japan:

A study published in March 2012 by Fumihiko IMAMURA¹⁹ and Suppasr ANAWAT summarized the destruction to 19,295 deaths and 359,073 houses destroyed¹⁹.

As a consequence, in 2011 Japan's government approved three supplementary budgets:²⁰

Despite a sharp drop in exports following the event, by the end of the year the Japanese production and exports rose to the anterior values.

The international community helped by raising the exemption radiation levels for food and livestock products to 1mSv/year.

Japan's annual budget for 2011 had been adjusted to include 597.1bln yen (6bln USD) assistance for disaster victims, 130.6bln Yen (1.5bln USD) for restoration assistance and 1,113bln Yen (11bln USD) for employment and labor assistance. This adds up to 1,804bln Yen (~20bln USD) extra budgetary allocation for 2011 alone.²¹ Since then, many additional announcements have been made by the Ministry of Health Labor and Welfare. The number of households that needed restoration of water supply rose to 2,260,000 by Feb 2012. Other departments reported damages and expenses caused by the event (for example the Ministry of Agriculture, Forestry and Fisheries reported a related loss of 2,384bln Yen (24bln USD)

Globally:

On global level, the financial markets recorded a worldwide drop amplified by the extensive media coverage as presented before. While Nikkei index dropped 16% in the first week, around the world the stock market recorded overall losses up to 2%. Oil prices also dropped quickly given the horizon of a slower than normal Japan production needs.

¹⁹ Fumihiko Imamura, Suppasr Anawat, *Proceedings of the International Symposium on Engineering Lessons Learned from the 2011 Great East Japan Earthquake*, March 1-4, 2012, Tokyo, Japan

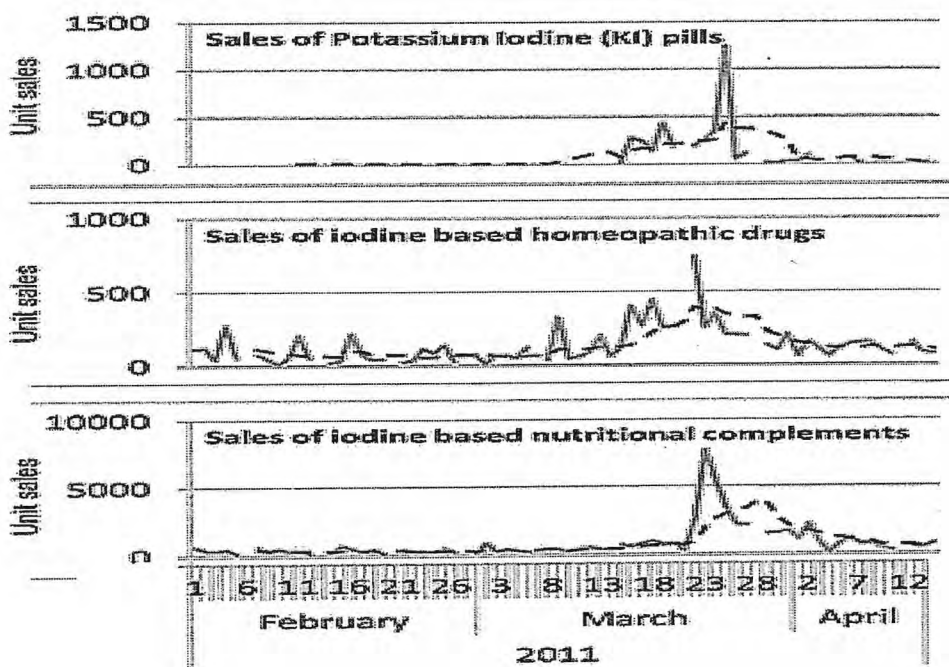
²⁰ Government of Japan, March 2012, *Road to recovery*,
http://www.kantei.go.jp/foreign/incident/pdf/road_to_recovery_1.pdf

²¹ Supplementary budget of fiscal year 2011 to the Ministry of Health, Labour and Welfare,
http://www.mhlw.go.jp/wp/yosan/yosan/11hosei/dl/hosei01_en.pdf

Shares of reinsurance companies like Munich Re , Aflac, Swiss Reinsurance , Barclays, Allianz recorded losses given the expected claims above \$10bln despite the Japanese government covering some of the cost. Automobile, machinery and electronics companies were also affected worldwide due to their reliance on Japanese production. General Electric Co and other companies which supplied equipment for the Fukushima Daiichi nuclear plant were feared to be affected by claims for the failed supplied nuclear systems. Such a claim was actually proposed but rejected in June 2013 during the TEPCO shareholders general annual meeting.²²

The Japanese Yen rose sharply on speculations that investors will send home funds for rebuilding purposes which triggered a G7 meeting on March 17th deciding an intervention on the foreign currencies exchange markets since a high yen value would have made the Japanese products more expensive on the international market and further impacting the economy.

Due to extensive coverage of the earthquake and nuclear disaster, some public overreaction to radiation danger was recorded with spikes in purchase of potassium iodide and Geiger counters. A French study published in Sept 2012 showed a 3-fold increase in demand during a period of 20 days following the event as outlined in the table below:



23

²² Jacob Adelman & Yuji Okada, Bloomberg, Jun 25, 2013 <http://www.bloomberg.com/news/2013-06-26/tepcos-shareholders-decline-to-pursue-ge-for-fukushima-claims.html>

²³ Pascal Crepey, Mathilde Pivette, Avner Bar-Hen, Quantitative Assessment of Preventive Behaviors in France during the Fukushima Nuclear Crisis, March 2013, <http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0058385>

4. Short and Medium Term Effects on Japan's and the Global Economy

While the economical consequences of the earthquake and tsunami have been clearly established and projected by the Japan government the continuing uncertainty about the Fukushima Daiichi plant evolution is still worrying.

As of Feb 2013:

On medium term, experts from JPMorgan Chase and Societe Generale expected that the disaster will actually boost Japan's economy. After an initial drop of 2.6% of GDP, Japan's economy accelerated through the next 2 years at more than the previous rates despite a number of 644 companies forced in bankruptcy by the disaster. Import of food based products in Japan is constantly increasing due to fear of local contaminated supply which negatively impacts fishing and agriculture in the prefectures in close proximity to Fukushima. South Korea banned recently imports for fish caught near the affected area while other countries including US and Canada imposed new regulations immediately after the incident.²⁴

Fukushima Daiichi situation:

After the 2.5 years that passed after the earthquake the situation at the Fukushima Daiichi nuclear plant is still extremely serious. Very little steps have been made so far to control the situation given the extremely perilous condition and lack of available adequate technology. Until now the reactors have been maintained under control mainly through extensive seawater injection which led to large amounts of contaminated water that cannot be safely stored and it is presently leaking into the ocean. The vast amounts of spent fuel rods have not been removed yet and the crippled reactors are releasing radioactive gases into the atmosphere. The most recent plans are to construct a 1.4km long and 30m deep ice underground wall surrounding the facility and block further water leakage at a cost of 47 billion yen. However this is an untested and unproven technique. Another 15bn is to be spent on improving the technology to remove radioactive particles from the contaminated water.²⁵

The initial cleanup estimate by TEPCO was at \$62bn which was more than doubled in Nov 2012 - \$125bn.²⁶ These estimates were prior to the new water leaks developed in July 2013 and the frozen wall plan. Only the cleanup of the evacuated area around the plant has been recently estimated at \$50bn.²⁷ TEPCO was nationalized last year and receives public funds to

²⁴ Sarah Schmidt, Postmedia News, March 23, 2011

<http://www.canada.com/news/Canada+steps+import+controls+Japanese+food+resists+outright/4489543/story.html>

²⁵ Justin McCurry, The Guardian, Sep 4, 2013 <http://www.theguardian.com/environment/2013/sep/03/japan-ice-wall-fukushima-water>

²⁶ RT.com, Nov 7, 2012 <http://rt.com/business/tepco-fukushima-costs-double-158/>

²⁷ fukushimaupdate.com citing NHK world, July 24, 2013 <http://fukushimaupdate.com/estimated-fukushima-decontamination-costs-blows-out-to-50b/>

pay compensation to the 160,000 people who had to flee their homes and has been granted 3.79 trillion yen (\$38.9 billion) by the government to settle compensation claims from the nuclear disaster. The company also had a 685.3 billion yen loss last fiscal year (2012).²⁸

The total estimated and budgeted cost so far for the reconstruction after the earthquake and tsunami destruction not including the Fukushima Daiichi plant reached \$266bln. The cost of the nuclear cleanup is still uncertain with present estimate at \$125bln. This adds up to a present total estimated cost of \$391bln.

Global medium term effects

After the initial shock on the financial markets, the Japanese economy recovered faster than predicted and their exports to worldwide beneficiaries were reestablished within months. The main area of the global economy impacted was the production of nuclear energy.

The general level of public opposition to nuclear power raised sharply around the world. Japan decided not to restart any reactor that goes offline for maintenance. Between May 24th 2012 and July 5th 2012 there were no active nuclear reactors in Japan and the 2 presently active are under public pressure to be shut down. In Germany 200,000 people took part in March 2011 in a protest against nuclear power and legislation has been passed to phase out the remaining reactors by 2022. Italy voted to remain non-nuclear while Switzerland and Spain have banned the construction of new reactors. Switzerland, which produces 40% of its energy in nuclear plants today decided to close all reactors by 2034. Other countries including US analyzed and modified their nuclear energy policies.²⁹

Germany decided to abandon nuclear energy and focus on green energy generation. All nuclear reactors are to be shut down by 2022. Fukushima disaster affected nuclear policies in several countries including China and the overall public support for nuclear energy dropped significantly (in US from 61% -2008 to 42% present).³⁰

Inspections of nuclear plants have been performed worldwide leading to some closures - one example is the San Onofre nuclear plant in Southern California which has been shut down in early 2012 following an inspection - the price of energy rose 20% within 1 year in the Californian region.³¹ In US which produces 20% of its energy in 100 nuclear plants no new nuclear plant has been allowed after the Three Mile Island accident in 1979 until recently when the construction of 2 new reactors has been approved in Georgia.³²

²⁸ Jacom Adelman, Yuji Okada, Bloomberg, June 28, 2103

<http://www.carriermanagement.com/news/2013/06/28/108978.htm>

²⁹ Wikipedia, International reaction to the Fukushima Daiichi nuclear disaster,

https://en.wikipedia.org/wiki/International_reaction_to_the_Fukushima_Daiichi_nuclear_disaster

³⁰ Steve Goreham, Aug 29, 2013, Energy Tribune <http://www.energytribune.com/78972/wind-turbines-clutter-the-north-german-countryside>

³¹ Dave Forest, Sep 1, 2013 What a World Without Nuclear Looks Like, <http://oilprice.com/Alternative-Energy/Nuclear-Power/What-a-World-Without-Nuclear-Looks-Like.html>

³² Siemens, One year after Fukushima – Germany's path to a new energy policy, March 2013 <http://www.siemens.com/press/pool/de/feature/2012/corporate/2012-03-energiewende/factsheet-e.pdf>

This change in energy production policies means a move towards traditional power generation from coal and natural gas and increased focus on future clean energy production. Since the incident we witnessed an enlarged LNG (liquid natural gas) demand in Japan and other Asian countries leading to a price increase which was previously on decline. European countries steered towards coal energy production.

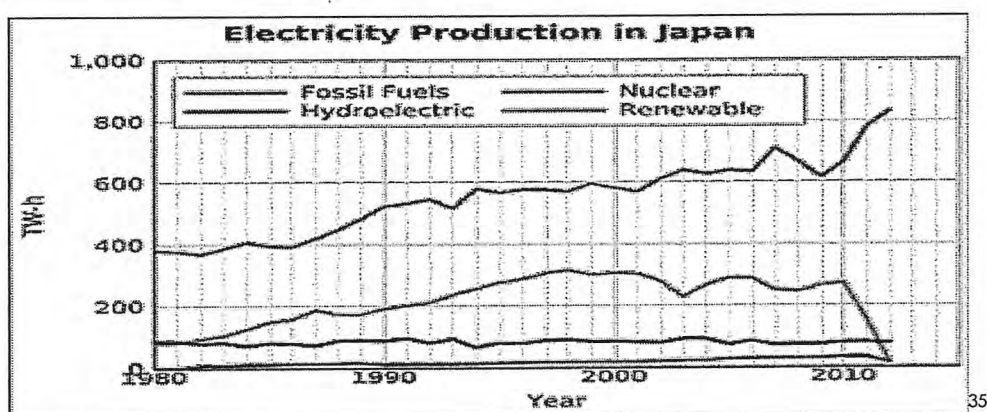
There are 1.5mil tons of tsunami debris floating across Pacific from which a significant amount is expected to end up on the US and Canada Pacific shores with Alaska being the most affected area. The Japanese government offered \$1mil assistance to British Columbia³³ and \$6mil to US for funding the floating debris removal. So far the amount of debris of confirmed origin is less than expected and plans are being developed for its management.³⁴

³³ Andrea Woo, *The Globe and Mail*, Sep 26, 2013 <http://www.theglobeandmail.com/news/british-columbia/japanese-officials-sifting-through-tsunami-debris-on-bc-coastline/article14561217/>

³⁴ Marine Conservation Alliance Foundation, *Plan for Clean Up*, Sep 2012 http://www.alaskamsf.org/wp-content/uploads/2013/02/A_plan_for_the_Clean_Up_of_Tsunami-Related_Marine_Debris_Off_AK_MCAF_Sept_2012.pdf

5. Long Term Economical Effects Projections Locally and Globally

As presented in the previous chapter, the effects of the earthquake and tsunami destruction were mostly localized to Japan and after the initial loss it actually catalyzed the Japanese economy. The reconstruction process is expected to continue which brings investments, creates new jobs and added value. The present shift towards traditional energy generation brings higher costs but on the long run it stimulates the development of new technologies, clean energy production, more efficient energy transport infrastructure and efficient consumption³⁹:



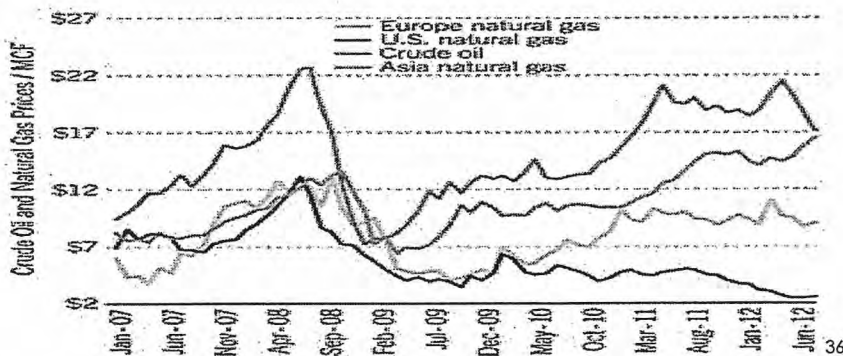
The most important problem which still remains unsolved is the status of the Fukushima Daiichi plant and cleanup of the surrounding area. The projected cost has been increased significantly several times without the certitude of a successful solution. The present estimated amount of \$125bln and a time span of 40 years may prove unrealistic especially since the actual exact status of the 4 affected reactors is not yet precisely determined.

The agricultural and fishing activities in the region are already compromised as they are totally dependent of the evolution at the crippled nuclear plant. Hopes of a quick recovery have been diminished after the leaks recorded in the summer of 2013.

On a global scale the developed countries maintain a trend to move away from nuclear energy which presently creates additional costs and generates pollution but the main focus is towards clean energy production through improved technologies. In many other countries with high energy needs like China, India, France, Russia or US, which will still rely on nuclear energy, there has been an important change in policies to improve security and monitoring of present facilities and only build most advanced and proven new plants. Another effect of this change is creating demand for coal, oil and gas which benefits countries with this kind of natural resources like Russia, US, Canada, Venezuela and Middle East countries.

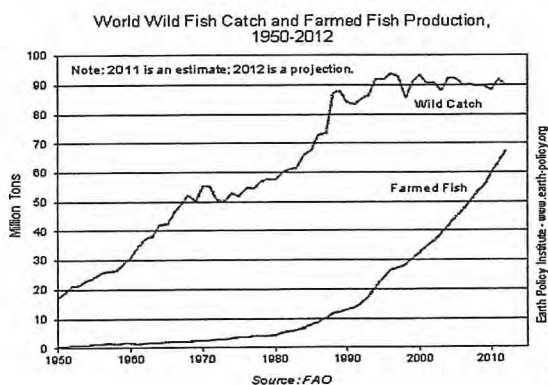
³⁵ Graph source - Wikipedia, Sep 2013, http://en.wikipedia.org/wiki/Energy_in_Japan

On this chart we can notice the price increase for natural gas in Asia after March 2011 - brown line:



The latest IEA report estimates global energy demand to increase by one third by 2035 with renewable sources increasing from \$88bln to \$240bln while coal and gas remaining the main source of energy.³⁷ This higher energy demand and rejection of nuclear energy is expected to maintain a high price of fossil fuels for the next decades.

Another consequence with uncertain evolution refers to the sea water pollution of the Pacific Ocean but so far the effects were localized within a few hundred miles of the Fukushima nuclear plant. Besides the ecological concerns, seafood is the main food source for Japan and many Asian countries in the region thus extensive and aggravated of radioactive releases may have unforeseen consequences. While this may become a regional problem, and affect less developed countries with population dependent on fishing as primary source of food, at a global level it may not be relevant since the farmed fish production is constantly rising in the past 30 years while the wild fish catch remained constant:



³⁶ From Daily Kos citing fidelity.com, March 25, 2013 <http://www.dailykos.com/story/2013/03/25/1196820/-The-new-economics-of-the-power-sector>

³⁷ International Energy Agency, World Energy Outlook, Nov 2012
<http://www.iea.org/publications/freepublications/publication/English.pdf>

³⁸ Earth Policy Institute, Fish Catch, Nov 19, 2012 <http://www.earth-policy.org/indicators/C55>

6. Conclusions

The Great Japan Earthquake was a tremendous manifestation of the destructive power of nature resulting in the loss many thousands lives, extensive material damage, changing the lives of millions of people and possibly shaping the future of our planet.

The economical cost on short and medium term is established and approaching a total of \$500bln including the long term estimate of the nuclear plant clean-up. This is the highest cost of a natural disaster ever recorded³⁶. While this is an important amount equivalent to almost one third of Canada's annual GDP it represents only one tenth of Japan's GDP and only 0.7% of the world total GDP of \$72 trillion. It did not cripple the Japanese economy, by the contrary it acted as a stimulus generating a higher economical growth rate compared to previous years.

There are environmental concerns due to radiation leaks and uncertainty upon the containment procedures which may raise the final costs and the international community is increasing pressure on Japan to act in a more effectively and in a timely manner. We simply lack the adequate technology today to properly deal with this kind of nuclear accidents and progress is slow but there is confidence that the situation will be contained and it will not degenerate.

The most important effect is the change in energy production policies around the world with a new focus for safety and renewable energy. Research for more efficient solar and wind power generation intensified along with increased efforts for nuclear fusion technology development. They became more competitive following the increase in price of power caused by shift towards fossil fuels. ITER is a multinational project for nuclear fusion funded by US, China, India Russia, South Korea, Japan and European Union with a budget of \$20bln. Parallel nuclear fusion projects are being developed in several other countries including Canada where the local Vancouver Company General Fusion is working on a unique prototype and received \$13.9mil funding³⁹ from the government.

There is today an increased level of awareness and concern on the use of possible dangerous technologies that may have devastating effects on our environment. Our generation will remember this terrible disaster that reminded us of the humble human condition facing the destructive forces of nature and will make us more conscious about the environment.

³⁹ General Fusion, Wikipedia, Sep 2013, http://en.wikipedia.org/wiki/General_Fusion

Bibliography

- "2011 Tōhoku Earthquake and Tsunami." *Wikipedia*. N.p., n.d. Web. 10 Oct. 2013.
<http://en.wikipedia.org/wiki/2011_T%C5%8Dhoku_earthquake_and_tsunami>.
- Adelman, Jacob, and Yuji Okada. "Tepco's Shareholders Decline to Pursue GE for Fukushima Claims - Carrier Management." *Carrier Management*. N.p., 28 June 2013. Web. 12 Nov. 2013.
<<http://www.carriermanagement.com/news/2013/06/28/108978.htm>>.
- Adelman, Jacob, and Yuji Okada. "Tepco's Shareholders Decline to Pursue GE for Fukushima Claims." *Bloomberg.com*. Bloomberg, 15 June 2013. Web. 10 Oct. 2013. <<http://www.bloomberg.com/news/2013-06-26/tepco-s-shareholders-decline-to-pursue-ge-for-fukushima-claims.html>>.
- Black, Richard. "Nuclear Power 'gets Little Public Support Worldwide'" *BBC News*. BBC, 25 Nov. 2011. Web. 10 Oct. 2013.
<<http://www.bbc.co.uk/news/science-environment-15864806>>.
- Digital image. *REPUTATION METRICS*. NewsReputation, 08 Mar. 2012. Web. 10 Oct. 2013. <<http://reputation-metrics.org/tag/media-coverage/>>.
- "Energy in Japan." *Wikipedia*. Wikimedia Foundation, n.d. Web. 13 Nov. 2013. <http://en.wikipedia.org/wiki/Energy_in_Japan>.
- "Estimated #Fukushima Decontamination Costs Blow out to \$50b." *Fukushima Update*. N.p., 24 July 2013. Web. 15 Oct. 2013.
<<http://fukushimaupdate.com/estimated-fukushima-decontamination-costs-blows-out-to-50b/>>.
- "The First Supplementary Budget of Fiscal Year 2011 to the Ministry of Health, Labour and Welfare." *Ministry of Health, Labour and Welfare*. N.p., n.d. Web. 10 Oct. 2013.
<http://en.wikipedia.org/wiki/Humanitarian_response_to_the_2011_T%C5%8Dhoku_earthquake_and_tsunami>.
- Flatow, Ira. "Japan Earthquake May Have Shifted Earth's Axis." *NPR*. NPR, 18 Mar. 2011. Web. 07 Feb. 2014.
<<http://www.npr.org/2011/03/18/134658880/Japan-Earthquake-May-Have-Changed-Earths-Axis>>.
- Forest, Dave. "What a World Without Nuclear Looks Like." *OilPrice*. N.p., 01 Sept. 2013. Web. 13 Nov. 2013.
<<http://oilprice.com/Alternative-Energy/Nuclear-Power/What-a-World-Without-Nuclear-Looks-Like.html>>.
- "Fukushima Daiichi Nuclear Disaster." *Wikipedia*. Wikimedia Foundation, n.d. Web. 10 Oct. 2013.
<http://en.wikipedia.org/wiki/Fukushima_Daiichi_nuclear_disaster>.
- "Fukushima Nuclear Plant Shutdown May Take Japan Longer than Predicted 40 Years, Warns U.N. Agency." *CBSNews*. CBS Interactive, n.d. Web. 10 Oct. 2013. <http://www.cbsnews.com/8301-202_162-57580704/fukushima-nuclear-plant-shutdown-may-take-japan-longer-than-predicted-40-years-warns-u-n-agency/>.
- Gaur, Aakanksha. "Japan Earthquake and Tsunami of 2011." *Encyclopedia Britannica Online*. Encyclopedia Britannica, 20 Aug. 2013. Web. 10 Oct. 2013. <<http://www.britannica.com/EBchecked/topic/1761942/Japan-earthquake-and-tsunami-of-2011>>.
- "2011 Tōhoku Earthquake and Tsunami." *Wikipedia*. N.p., n.d. Web. 10 Oct. 2013.
<http://en.wikipedia.org/wiki/2011_T%C5%8Dhoku_earthquake_and_tsunami>.
- Adelman, Jacob, and Yuji Okada. "Tepco's Shareholders Decline to Pursue GE for Fukushima Claims - Carrier Management." *Carrier Management*. N.p., 28 June 2013. Web. 12 Nov. 2013.
<<http://www.carriermanagement.com/news/2013/06/28/108978.htm>>.
- Adelman, Jacob, and Yuji Okada. "Tepco's Shareholders Decline to Pursue GE for Fukushima Claims." *Bloomberg.com*. Bloomberg, 15 June 2013. Web. 10 Oct. 2013. <<http://www.bloomberg.com/news/2013-06-26/tepco-s-shareholders-decline-to-pursue-ge-for-fukushima-claims.html>>.
- Black, Richard. "Nuclear Power 'gets Little Public Support Worldwide'" *BBC News*. BBC, 25 Nov. 2011. Web. 10 Oct. 2013.
<<http://www.bbc.co.uk/news/science-environment-15864806>>.
- Digital image. *REPUTATION METRICS*. NewsReputation, 08 Mar. 2012. Web. 10 Oct. 2013. <<http://reputation-metrics.org/tag/media-coverage/>>.
- "Energy in Japan." *Wikipedia*. Wikimedia Foundation, n.d. Web. 13 Nov. 2013. <http://en.wikipedia.org/wiki/Energy_in_Japan>.
- "Estimated #Fukushima Decontamination Costs Blow out to \$50b." *Fukushima Update*. N.p., 24 July 2013. Web. 15 Oct. 2013.
<<http://fukushimaupdate.com/estimated-fukushima-decontamination-costs-blows-out-to-50b/>>.
- "The First Supplementary Budget of Fiscal Year 2011 to the Ministry of Health, Labour and Welfare." *Ministry of Health, Labour and Welfare*. N.p., n.d. Web. 10 Oct. 2013.
<http://en.wikipedia.org/wiki/Humanitarian_response_to_the_2011_T%C5%8Dhoku_earthquake_and_tsunami>.
- Flatow, Ira. "Japan Earthquake May Have Shifted Earth's Axis." *NPR*. NPR, 18 Mar. 2011. Web. 07 Feb. 2014.
<<http://www.npr.org/2011/03/18/134658880/Japan-Earthquake-May-Have-Changed-Earths-Axis>>.
- Forest, Dave. "What a World Without Nuclear Looks Like." *OilPrice*. N.p., 01 Sept. 2013. Web. 13 Nov. 2013.
<<http://oilprice.com/Alternative-Energy/Nuclear-Power/What-a-World-Without-Nuclear-Looks-Like.html>>.
- "Fukushima Daiichi Nuclear Disaster." *Wikipedia*. Wikimedia Foundation, n.d. Web. 10 Oct. 2013.
<http://en.wikipedia.org/wiki/Fukushima_Daiichi_nuclear_disaster>.

- "Fukushima Nuclear Plant Shutdown May Take Japan Longer than Predicted 40 Years, Warns U.N. Agency." *CBSNews*. CBS Interactive, n.d. Web. 10 Oct. 2013. <http://www.cbsnews.com/8301-202_162-57580704/fukushima-nuclear-plant-shutdown-may-take-japan-longer-than-predicted-40-years-warns-u-n-agency/>.
- Gaur, Aakanksha. "Japan Earthquake and Tsunami of 2011." *Encyclopedia Britannica Online*. Encyclopedia Britannica, 20 Aug. 2013. Web. 10 Oct. 2013. <<http://www.britannica.com/EBchecked/topic/1761942/Japan-earthquake-and-tsunami-of-2011>>.
- "One Year after Fukushima – Germany's Path to a New Energy Policy." *Siemens*. N.p., Mar. 2012. Web. 12 Nov. 2013. <<http://www.siemens.com/press/pool/de/feature/2012/corporate/2012-03-energiewende/factsheet-e.pdf>>.
- París, Jerome A. "The New Economics of the Power Sector." *Daily Kos*. N.p., 25 Mar. 2013. Web. 12 Nov. 2013. <<http://www.dailykos.com/story/2013/03/25/1196820/-The-new-economics-of-the-power-sector>>.
- "A Plan for the Clean up of Tsunami Related Marine Debris of Alaska." *MCA Foundation*. N.p., Sept. 2012. Web. 16 Oct. 2013. <http://www.alaskamsf.org/wp-content/uploads/2013/02/A_plan_for_the_Clean_Up_of_Tsunami-Related_Marine_Debris_Off_AK_MCAF_Sept_2012.pdf>.
- "Quantitative Assessment of Preventive Behaviors in France during the Fukushima Nuclear Crisis." *PLOS ONE*. N.p., 07 Mar. 2013. Web. 10 Oct. 2013. <<http://www.plosone.org/article/info%253Adoi%252F10.1371%252Fjournal.pone.0058385>>.
- Roney Matthew. "Eco-Economy Indicators." *Earth Policy Institute*. N.p., 19 Nov. 2012. Web. 12 Oct. 2013. <<http://www.earth-policy.org/indicators/C55>>.
- SCHMIDT, SARAH. "Canada Steps up Import Controls for Japanese Food, Resists Outright Ban." *Www.canada.com*. N.p., 13 Mar. 2011. Web. 10 Oct. 2013. <<http://www.canada.com/news/Canada%2Bsteps%2Bimport%2Bcontrols%2BJapanese%2Bfood%2Bresists%2Boutright/4489543/story.html>>.
- "TEPCO to Seek \$125bln as Fukushima Costs Double - RT Business." *RT Business*. N.p., 07 Nov. 2012. Web. 13 Nov. 2013. <<http://rt.com/business/tepcu-fukushima-costs-double-158/>>.
- "Tyndall Report | Year in Review 2011." *Tyndall Report*. N.p., n.d. Web. 10 Oct. 2013. <<http://tyndallreport.com/yearinreview2011/>>.
- Woo, Andrea. "Japanese Officials Sifting through Tsunami Debris on B.C. CoastlineAdd to ..." *The Globe and Mail*. N.p., 27 Sept. 2013. Web. 10 Nov. 2013. <<http://www.theglobeandmail.com/news/british-columbia/japanese-officials-sifting-through-tsunami-debris-on-bc-coastline/article14561217/>>.
- "World Energy Outlook." *International Energy Agency*. N.p., Nov. 2012. Web. 14 Oct. 2013. <<http://www.dailykos.com/story/2013/03/25/1196820/-The-new-economics-of-the-power-sector>>.